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A PRELIMINARY DRAFT FEASIBILITY STUDY FOR RESEARCH ON ENDANGERED KANAB AMBERSNAIL USE OF NATIVE AND NON-NATIVE HOST PLANTS IN GRAND CANYON, ARIZONA: A THREE PHASE PROJECT

GLEN CANYON ENVIRONMENTAL
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BACKGROUND

The Kanab ambersnail (Oxyloma haydeni kanabensis Pilsbry), is a federally endangered landsnail with extant populations at two springs in the southwestern United States (Pilsbry and Ferris 1911, Pilsbry 1948, Spamer and Bogan 1993). However, only the Vaseys Paradise population in Grand Canyon National Park is protected. Vaseys Paradise is a cool, dolomitic spring which pours from the sheer Mississippi Redwall Limestone and forms several small rivulets as it flows 100m to the Colorado River. The vegetation around the spring forms a lush stand of wetland and riparian habitat and is distributed in relation to steep moisture gradients. The two primary plant species at Vaseys Paradise on which the Kanab ambersnail occurs are: native Mimulus cardinalis (crimson monkeyflower) and the non-native Nasturtium officinale (water-cress). These two species of plants are primary host plants and the snails are rare or absent on other plant species or substrates (Stevens et al. 1995).

Studies on the ecology and habitat use of the Vaseys Paradise Kanab ambersnail population were conducted in 1994 and 1995 (Stevens et al. 1995). The Kanab ambersnail has an approximately annual life cycle, as indicated by size class frequency distributions. Young ambersnails overwinter on host plant stems and emerge from winter dormancy in middle to late March, reproducing in mid-summer. Mean densities of ambersnails were greater on water-cress than on native monkeyflower throughout the growing season; however, the ratio of ambersnails on watercress to ambersnails on monkeyflower increased significantly during and after peak reproduction in mid to late summer. From 8.5% to 8.9% of the total population in August 1995 were parasitized by a trematode, Leucochloridium cyanocittae. The definitive host (if any) and the mode of transmission are not known; however, slower movement in parasitized snails has been observed and fecundity is likely to be affected (Stevens et al. 1995).

INTRODUCTION

We present a 3-phase proposal involving laboratory study, habitat establishment, and initial establishment of an experimental Kanab ambersnail population. The U.S. Fish and Wildlife Service Recovery Plan (1995) for Kanab ambersnail species states that 10 additional Kanab ambersnail populations are to be discovered or established before the species can be downlisted or delisted, and least one of these populations is expected to be in Arizona. Recovery activities include inventories of numerous springs for additional Kanab ambersnail populations and identification of suitable secondary habitats. These activities are proceeding but will require considerable time. Meanwhile, Ecosystem management of the Colorado River in Grand Canyon depends on the ability of the Bureau of Reclamation to conduct habitat building flows. We propose to conduct a feasibility study to determine whether Kanab ambersnail habitat and an experimental population can be established at Glen Canyon Dam.

PHASE I

INTRODUCTION

To successfully establish secondary populations, additional information is needed concerning the life history of the snail. Rearing Kanab ambersnail egg masses through their entiré life cycle in a laboratory environment will provide significant insight into the life history of the ambersnail. In relation to the recovery plan objectives, other questions to be answered include Kanab ambersnail growth rates on the native and non-native host plants, and effects of parasitism on demographic rates. Growth and fecundity analysis of Kanab ambersnail on the two host plant species may be used to determine if any benefits accrue to the snail in changing host plants during particular times in its life cycle. The impacts of parasitism may affect fecundity, growth rates, plant preference, and therefore the snail population. These are important questions which must be answered to enable us to construct a life history model of the Kanab ambersnail and to advance understanding of the potential for recovery.

SPECIFIC OBJECTIVES

1. Literature review.
2. Collect data on host plant seed longevity, life cycle, and successful propagation techniques.
3. Collect data on survivorship, growth rates, and fecundity for two generations of the Kanab ambersnail grown on each of the two host plant species in the NAU laboratory.
4. Evaluate the frequency of parasitism in Kanab ambersnails at Vaseys Paradise (optional).
5. Develop a life history model of Vaseys Paradise Kanab ambersnail.

METHODS

Objective 1: Literature review.

A complete review of all relevant literature on Kanab ambersnail, succineid ecology, parasitism of molluscs, ecology of Leucochloridium, and host plant shifts among invertebrates will be conducted.

Objective 2: Collect data on host plant seed longevity, life cycle, and successful propagation techniques.

Experiments will be run using Mimulus and Nasturtium seeds taken from plants at Vaseys Paradise. Seeds will be taken from each plant and stored in appropriate field and laboratory conditions. Seeds will be germinated at regular (monthly) intervals until a reasonable estimation of seed longevity is determined. Each of the two host plants will be propagated in controlled environments in order to manipulate physical parameters and better understand phenology and life cycle. Plants will also be propagated at the Glen Canyon Dam site in Page, Arizona using nine separate growing enclosures. The success of these plantings will provide a good indication of whether an alternative Kanab ambersnail population may be successfully established.

Objective 3: Collect data on survivorship, growth rates, and fecundity of the Kanab ambersnail on each of the two host plant species.

During the first year of research, a minimum of ten samples of each of the two host plants will be propagated in separate aquaria at Northern Arizona University (NAU). Kanab ambersnail egg masses or very small Kanab ambersnails will be collected at Vaseys Paradise, instead of mature individuals, to insure a parasite-free population. Individual egg masses will be placed on each of the two primary host plants. Observations of hatching success, survivorship, plant consumption, growth rates, fecundity, and behavior on each of the host plants will be made. Experiments will also be conducted to determine if and when host plant preference exists in the ambersnail life cycle. Plant preference will be determined by observing snails in aquaria with both host plants.

Objective 4: Study the effects of parasitism on Kanab ambersnail growth rates, survivorship, and fecundity.

After information is collected regarding the effects of host plants on snail life history, growth rate measurements will be repeated in year 2. If Leucochloridium persists in sufficient numbers at Vaseys Paradise, experiments similar to those in objective 2 will be conducted using parasitized snails. The frequency of Leucochloridium parasitism will be monitored in the field. If parasitism rates are high, the three-level trophic interaction between the parasite, snail, and host plant will also be investigated by comparing parasitized and non-parasitized snail behavior, growth and fecundity in the laboratory.

Objective 5: Alternative food palatability studies.

Alternative host plants will also be used to test palatability, fecundity, growth rates, and survivorship. This information will provide insight into ambersnail ecology, as well as possibly broaden the number and ease of establishing other populations of the Kanab ambersnail.

EXPECTED OUTPUTS OR BENEFITS:

Objective 1: A clear and comprehensive understanding of existing research related to Kanab ambersnail ecology and propagation, which may be applied to the successful rearing of captive Kanab ambersnails.

Objective 2: Valuable information regarding host plant life-cycles, seed longevity, and propagation will facilitate the successful establishment of alternative Kanab ambersnail primary habitat.

Objective 3: Obtain empirical data pertaining to Kanab ambersnail host plant preference. The high Nasturtium:Mimulus snail density ratio suggests a preference for Nasturtium. An increase in growth rates and/or higher fecundity and survivorship on Nasturtium is therefore expected. Possible benefits to the Kanab ambersnail from switching host plants during its life cycle may also accrue. Information on differential demographic rates will provide valuable insight into Kanab ambersnail life history.

Objective 4: Snails that are parasitized are expected to have a lower growth rate, survivorship, and fecundity. A better understanding of the potential impact of parasitism on Kanab ambersnail demography is also expected.

Objective 5: Alternative habitat selection for Kanab ambersnail population establishment will be advanced due to more information on food palatability. Information on Kanab ambersnail host plant use and preference can be used to facilitate the establishment of experimental secondary populations.

PHASE II

SPECIFIC OBJECTIVES

1. Planning Kanab ambersnail habitat construction with interagency consultation.
2. Construction of Kanab ambersnail habitat and propagation of host plants.

METHODS

Objective 1: Planning Kanab ambersnail habitat construction with interagency consultation.

Tentative habitat construction plans are proposed here, but may be altered pending interagency discussion. Nine 1-m^2 boxes will be constructed on the lawn area at the base of Glen Canyon Dam, arranged to most closely mimic the physical parameters found at Vaseys Paradise (i.e., hours of sunlight, temperature, etc). Each 1-m^2 box will be built using plexiglass sides 1 m long and .25 m high. Wire mesh will be placed on the top of each box to protect Kanab ambersnails from predation while allowing water and sunlight to reach the plants. Temperature will be monitered to evaluate thermal regimes within the enclosures. A starting substrate of rocks will be placed in the enclosure covered with 3-5 cm of topsoil. A solar panel will be placed on the lawn to power a pump that will draw water from the sump at the base of the dam. Plants will be watered by a timed garden drip system on a constant to hourly basis. There will be three sets of three enclosures, one set will contain only Mimulus, one set will contain only Nasturtium, and the third set will contain a mix of both species.

Objective 2: Construction of Kanab ambersnail habitat and propagation of host plants.

After an interagency consensus has been reached regarding the technical aspects of construction, Kanab ambersnail host plants (Mimulus cardinalis and Nasturtium officinale) will be propagated in the enclosures using expertise gained from laboratory studies of the two host plants.

EXPECTED OUTPUTS OR BENEFITS:

Objective 1: Construction of nine Kanab ambersnail habitat enclosures.

Objective 2: Successful propagation of primary habitat for the endangered Kanab ambersnail.

PHASE III

SPECIFIC OBJECTIVES

1. Establishment of experimental Kanab ambersnail population at Glen Canyon Dam.

METHODS

Objective 1: Establishment of experimental Kanab ambersnail population at Glen Canyon Dam.

Three or more Kanab ambersnail egg masses will be placed in each of the constructed habitat enclosures in mid-summer of 1998. Development of young Kanab ambersnails will be monitored using the techniques of Stevens et al (1995) to determine growth and survival. Pending laboratory experiments, emigration of young Kanab ambersnails will be prevented by bead of non-toxic silicon grease along the top edge of the plexiglass wall. Growth and survivorship will be compared between the three host plant combinations (Mimulus, Nasturtium, Mimulus/Nasturtium) for one full generation before expanding patch size and proceeding with establishment of a larger experimental population.

EXPECTED OUTPUTS OR BENEFITS

Objective 1: The successful establishment of an experimental Kanab ambersnail population.

DELIVERABLES: PHASE I

- Initiate project September 1996.
- A first prospectus and take plan will be prepared before November 1996. This document will contain detailed background information, hypotheses to be tested, methods, and a well-defined schedule of expected outputs.
- Quarterly and annual reports to the Bureau of Reclamation and the U.S. Fish and Wildlife Service in 1997 and 98.
- A final report and data will be provided at the end of FY 1998.
- Information regarding the successful propagation of Kanab ambersnail habitat.
- Preparation of a manuscript for submission for publication in a peer-reviewed scientific journal.
- Completion of an NAU Masters of Science thesis.

DELIVERABLES: PHASE II

- Quarterly and annual draft/final reports on Kanab ambersnail habitat construction and host plant propagation.
- We will provide the Bureau with photographs and text for the development of a public education poster.

DELIVERABLES: PHASE III

- Quarterly and annual monitoring reports will be prepared on the establishment of the Kanab ambersnail population.
- Results will be prepared for a peer-reviewed scientific publication.

BUDGET	FY97	FY98	TOTAL
PHASE I AND II			
• Research stipend for Clay B. Nelson ($13,500 per year; 1996/97 and 1997/98)	13,500	13,500	27,000
• Overhead costs for Northern Arizona University(20%)	2,700	2,700	5,400
• Benefits 1%	135	135	270
• Equipment costs (aquaria and field supplies) Paid for by the Department of The Interior	1,915	1,915	3,830
• Office, graphics and page costs (NAU)	750	750	1,500
• Subtotal of NAU Costs	17,085	17,085	34,170
• Subtotal of non-NAU costs	1,915	1,915	3,830
• TOTAL PHASE I AND II	19,000	19,000	38,000

STAFF

Clay Nelson was accepted into the Department of Biological Sciences at Northern Arizona University in January 1996. During the spring of 1996 he served as a volunteer during several of the Colorado River trips associated with the controlled flood from Glen Canyon. In May 1996, in conjunction with the National Park Service, Mr. Nelson collected plant specimens from the Kanab ambersnail habitat and began growing the plants in a laboratory setting at NAU. Mr. Nelson, under the direction of Dr. Peter Price in the Department of Biological Sciences, has agreed to meet the objectives in the time frames outlined in this proposal.

ACKNOWLEDGMENTS

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